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THE ZAPOROZHSTAL' ROLLING MILLS

Engr Z. Zaglerz

(The following article is from the Polish periodical Hutnik, No 9 and 10, 1948)

Construction was begun on the Zaporozhstal' Plant imeni Sergo Ordzhonikidze in 1931, and in 1937 production was begun in a blooming mill and a heavy plate mill. In 1938 a continuous hot strip mill was put into operation, and in 1939 production was started in a cold strip and light sheet mill. In 1941 the plant was evacuated and removed to the interior of the country.

The plant buildings were completely destroyed during the occupation. Reconstruction began in the second half of 1946, and the principal effort was directed toward supplementing the plant's equipment and replacing parts lost during the evacuation. It was planned that the blooming mill should begin production in July 1947, the hot strip mill in August, and the cold strip and light sheet mill in September 1947. Because of the great load which had already been placed on the country's machine factories, most of the work was accomplished in the plant's own small workshops, which contained 27 machine tools, and the target dates were met.

The Zaporozhstal' installation receives 6,000-volt current from the Dneproenergo network. Two Ward-Leonard aggregates are used to provide power.

The blooming mill, plate mill, and continuous hot strip mill are contained in one large building of iron construction. The hall is 1,028 meters long from the soaking pits to the end of the continuous strip mill. The width of the building ranges from 27 to 33 meters. The total installed area of the plant is 121,900 square meters, and the volume of the building is 2,215,000 cubic meters.

Installation of the equipment was difficult because of the great weights involved and the shortage of cranes. The heavy plate produced by the plant

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ranges from 6 to 25 millimeters, while the hot-rolled light sheet has a minimum thickness of 1.6 millimeters and the cold-rolled light sheet may be from 0.25 to 1.5 millimeters.

Blooming Mill

The blooming mill consists of two horizontal and two vertical rolls. Each of the horizontal rolls is driven by a 5,000-horsepower DC motor with a speed which can be regulated from 0 to 100 revolutions per minute. The two vertical rolls are driven by one 2,500-horsepower DC motor with a speed which can be regulated from 0 to 275 revolutions per minute. Each of the vertical rolls is 680 millimeters in diameter, and each has a minimum and maximum lift of 600 and 1,800 millimeters, respectively. The run is 1,200 millimeters long and the rollers can be brought into place at a rate of 33 millimeters per second.

Each of the horizontal rolls is 1,100 millimeters in diameter, and each has a minimum and maximum lift of 65 and 900 millimeters, respectively. The length of the run is 2 meters and the rolls can be brought into place at a rate of 54 millimeters per second.

The mill rolls flat ingots weighing from 4.5 to 15 tons into flat blooms from 65 to 200 millimeters thick, 600 to 1,500 millimeters wide, and 1,500 to 4,500 millimeters long.

The blooming mill uses one 8,000-horsepower synchronous motor, three 3,500-kilowatt generators, and an 85-ton flywheel.

The rolls are placed on two cast steel frames, which also hold the equipment for bringing the rolls into place. The bearings for the horizontal rolls are of cast steel with synthetic resin bushings, while the bearings for the vertical rolls are made of bronze with a high tin content. The horizontal rolls are of cast steel and the vertical rolls are forged.

The upper horizontal roll and both vertical rolls are brought into place by independent synchronous electric equipment. The rolls are water-cooled, and their necks are lubricated centrally. The roll stand weighs 762 tons, not including the electrical equipment.

Ingots are carried from the molds to the soaking pits. There are eight groups of these pits, consisting of four chambers each, and they are heated by blast-furnace gas.

All the work of the blooming mill is automatic, and all equipment is lubricated centrally. The entire mill weighs 4,200 tor This roll stand has a guaranteed annual capacity of 1,600,000 tons. About 700,000 tons of this consist of blooms for automobile sheet metals containing 0.18 percent carbon. The average weight of ingots processed is 8.5 to 9 tons.

Continuous Hot Strip Mill

Billets are heated in three 3-row recuperative furnaces. Each furnace can handle 40 tons per hour if the billets are inserted cold, and 60 tons per hour if they are inserted hot. The furnaces have modern control instruments, and are 19.8 meters long with fireboxes 5.5 meters wide. The air is preheated to 400 degrees centigrade, and a mixture of blast-furnace gas and coke-oven gas with a caloric content of about 2,000 calories per cubic meter is used. The heated billets are then conveyed on a roller train 50.4 meters long to a two-high rolling mill which removes scale; this scale is carried away by water under a pressure of 70 atmospheres.

The billets are then carried to a four-high broadside stand with working rolls 940 millimeters in diameter and backing rolls 1,320 millimeters in diameter. This stand has a run of 2,440 millimeters and rolls at 0.91 meter per second. It is powered by a 3,000-horsepower motor which turns at 214 revolutions per minute.

From here the billets go by roller table to a squeezer. This installation can handle billets up to 175 millimeters thick and from 840 to 1,600 millimeters wide, and can compress a billet a maximum of 120 millimeters. This squeezer is followed by a stand of vertical rolls which roll the edges of the billet. The billet then goes through the first stand of roughing rolls and another stand of vertical rolls. This process continues through a total of three vertical stands and three four-high roughing stands. The working rolls of the roughing stands, which are of cast iron or forged, are 610 millimeters in diameter, and the backing rolls, which are steel castings, are 1,240 millimeters. Each roughing stand has a run of 1,680 millimeters, and is powered by a 3,000-horsepower motor which runs at 600 revolutions per minute. The first roughing stand rolls at a rate of 1.03 meters per second, the second at 1.52, and the third at 2.46 meters per second. The broadside stand reduces the thickness of the billet by 24 to 50 percent, while the first roughing stand reduces it by a further 23 to 45 percent, the second roughing stand by 20 to 43 percent, and the third by 18 to 42 percent.

The material then goes through another scale breaker, across a 50-meter roller table, and the finishing stands. There are six of these four-high stands. The size and composition of the rolls are the same as those of the roughing rolls. Each finishing stand has a run of 1,680 millimeters, and the rolling speed increases from 0.77 - 1.78 meters per second for the first stand to 1.16 - 2.66 for the second, 2.00 - 4.00 for the third, 2.81 - 5.63 for the fourth, 3.50 - 7.00 for the fifth, and 3.83 - 7.66 for the sixth. The finishing stands are driven by 3,500-horsepower motors which can be regulated from 175 to 400 revolutions per minute.

The roller table leading to the finishing stands is equipped with air pipes which can blow air on the strip at a pressure of 1,400 millimeters of water. This is to control the temperature of the strip as it enters the finishing rolls.

Some strip is treated in an annealing furnace which has a firebox of 30.5 by 2.5 meters and is heated by gas. After annealing, some of the high-quality strip is pickled in a bath of 8- to 12-percent sulfuric acid. There are also three machines for straightening the finished strip; these have 17 rolls.

Finally, there are two four-high roller levelers with a run of 1,680 millimeters. The working rolls are 420 millimeters, and the backing rolls 1,210 millimeters, in diameter.

Each roll stand of this mill is enormous; the frames weigh 90 tons, while the working rolls of the four-high stands weigh 7 tons each and the backing rolls about 22 tons. Each roll stand weighs a total of about 290 tons, not including electrical equipment.

The hot strip mill is built to produce sheet and strip from 600 to 1,500 millimeters wide and from 1.6 to 6.0 millimeters thick; if necessary, it can produce plate up to 12 millimeters thick. Sheet and plate are produced in lengths from 2,500 to 8,500 millimeters. The mill can turn out 800,000 to 900,000 tons annually.

Cold Sheet Mill

This mill is located in a building 515 meters long, 66,000 square meters in area, and 168 meters wide at its widest point. This building is located parallel to the hot strip mill, with which it is connected by an underground tunnel. The tunnel is used to transport rolls of strip to the storehouse and to the two continuous pickling aggregates.

Rolling is accomplished either by a continuous mill consisting of three four-high stands or on a single four-high reversing roll stand. The working rolls of all the four-high stands are 485 millimeters, in diameter, while the backing rolls of the continuous stands are 1,240 millimeters, and those of the reversing stand are 1,370 millimeters, in diameter. Each stand has a run of 1,680 millimeters. The rolling speed increases from 0.98 - 1.96 meters per second for the first continuous stand to 1.35 - 2.70 for the second, and 1.70 - 3.40 for the third stand. Each stand is driven by a 1,500-horsepower motor and can turn from 250 to 500 revolutions per minute.

The reduction in the first stand of the continuous mill is 25 to 30 percent, in the second 30 to 35 percent, and in the third 15 to 20 percent, with a total reduction of from 50 to 60 percent. This mill can produce 26 tons per hour of strip 1,250 millimeters wide and 1.4 millimeters thick, or 15 tons per hour of strip with a width of 750 millimeters and a thickness of 0.6 millimeter. The continuous mill is expected to produce 200,000 tons per year.

The rolling speed of the reversing stand can be varied from 1.98 to 3.30 meters per second. The stand has a 2,250 horsepower motor which can turn from 300 to 500 revolutions per minute. The reversing stand is modern and its output is nearly that of the continuous mill. Reduction on one pass may reach as high as 50 percent; thus, the work moves very quickly.

The temperature of the rolls is controlled automatically. A stream of water and oil emulsion maintains a constant temperature of about 52 degrees centigrade.

Each continuous pickling aggregate is 120 meters long. It contains a spot welder for strip, a machine for straightening strip, four pickling baths, two washing baths, drying equipment, and shears. The pickling baths are 18,000 millimeters long, 1,828 millimeters wide, and 2,290 millimeters deep, and the washing baths, one containing cold water and the other hot, are 7,930 by 2,000 by 1,070 millimeters. The baths are surrounded by acid-resistant concrete. The first two pickling baths contain 10- to 15-percent solutions of sulfuric acid, while the concentration is 4 - 6 percent in the second two; the temperature of the solutions is maintained automatically at 90 degrees centigrade. The strip is drawn through the baths at between 175 and 700 millimeters per second, and it takes 2 - 3 minutes for the pickling process.

A transverse rolling mill was constructed before the war to cold roll sheet between 1,500 and 2,000 millimeters wide. Material came directly from the hot mill or the reversing mill. Although this mill achieved reductions of from 20 to 30 percent in one pass, the results were not satisfactory, since the material was roughened from being rolled transversely. Consequently, the mill was not rebuilt after the war.

After leaving the continuous mill, the sheet is washed in a hot solution of soda lye and in hot water, to remove the oil remaining after cold rolling. Then the sheet is dried and conveyed to the annealing ovens. The sheet travels through washing and drying at a rate of 0.45 to 1.8 meters per second.

Some of the sheet is heat-treated in muffle furnaces. When the rolling has resulted in a reduction of 50 to 60 percent, the metal is treated at 600 to 700 degrees centigrade.

The sheet may also be treated in a continuous furnace with an area 36 by 2.75 meters. The sheet is drawn through at 0.04 to 0.167 meter per second, and the furnace can treat 8.5 tons per hour. Scale is removed after this by pickling the sheet in a 5- to 10-percent solutuion of sulfuric acid; the sheet is then washed and dried. There are two washing and drying machines, one for sheet up to 1,500 millimeters wide and the other for sheet up to 2,000 millimeters wide.

Most narrow strip is rolled in four two-high roller levelers with a diameter of 1,110 millimeters, while all wide sheets are treated in two four-high stands. These roller levelers can turn out 125 tons per hour.

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